

WILL VIRTUALLY IMPERMEABLE FILMS ELIMINATE METHYL BROMIDE EMISSIONS FROM PRE-PLANT FUMIGATION?

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There are many soil-chemical processes which affect the fate and transport of fumigants in agricultural soils. Generally, three factors must be controlled to reduce emissions while Maintaining adequate efficacy: containment, degradation and soil-gas distribution. Probably the most reliable method to reduce the amount of methyl bromide (MeBr) leaving the treated soil involves the use of virtually-impermeable plastic films. To demonstrate this, a recent field experiment was conducted using the traditional high-density polyethylene (HDPE) and a virtually-impermeable film (VIF), Hytibar (Klerks Plastic, Belgium), to cover triplicated field plots treated with MeBr at a rate of 280, 210 or 140 kg/ha. At the beginning of the experiment, 2 bags containing citrus nematodes (*Tylenchulus semipenetrans*), Yellow Nutsedge seeds (*Cyperus esculentus*) and fungi (*Rhizoctonia solani*) were placed 10-15 cm deep in each plot to determine the effectiveness of the fumigation. During the course of the experiment, the volatilization rate was continuously measured over 3 hour intervals using two or more flux chambers. After the experiment, soil bromide concentration was measured to provide information for a mass balance. It was found that MeBr emissions were reduced from approximately 60% using current practices to less than 5% when VIF together with an 210 kg/ha application rate and a 10-day cover period were used. VIF offer several advantages f6known in advance and films are more uniform in space and time compared to soil-based methods.

Emissions of methyl bromide from pre-plant soil fumigation have been shown to be highly variable (Table 1). Total volatile losses are due to many interrelated soil and environmental factors which are difficult to control.

Table 1. Summary of Recent Experiments Measuring Methyl Bromide Volatilization

Table 1. Summary of Recent Experiments Measuring Methane Emissions from Ruminants													
Method	MeBr Injection Intervals	Estimate Applied [cm]	Surface Losses	Per Sampling	Mass Field Size Applied [ha]	Source Mass [%]	Volatile [kg/ha]	MeBr [%]	Balance				
Chamber	25-30	PE	14	17	256	268-298	87-	Yagi et al. (1993, 1945)					
Chamber	25-30	PE	11	1	242	110	34				104		
ADM	25-30	Bare	31	6	199	177	89	Majewski et al. (1995)					
ADM	25-30	PE	33*	4	262	94	32				---		
Br	25-30	PE	2	3.5	241	148 (±47)§	6Yates et al. (1996a-c)	101†					
ADM	25-30	PE	105	3.5	241	150 (± 91)	62						
TPS	25-30	PE	105	3.5	241	145 (±29)	60						
IHF	25-30	PE	105	3.5	241	168 (± 6)	70						
Chamber	25-30	PE	107	3.5	241	133 (± 49)	59						
Br	69	Bare	2	3.5	324	67 (±9)§	21	Yates et al. (1997)					
ADM	69	Bare	164	3.5	324	15 (±4)	5						
TPS	69	Bare	164	3.5	324	23	2						
IHF	69	Bare	164	3.5	324	6(±1)	2						
Chamber	69	Bare	173	3.5	324	16(±10)	5						
Chamber	25-30	PE	n/a (Site 1)			66	Williams et al. (1997)						
Chanter	25-30	PE	n/a, (Site 2)			77,44					n/a		
Chamber	25-30	PE	n/a, (Site 3)			34					n/a		

† Measured Mass Remaining 0.26 kg

§ Values in parentheses are standard deviations

* In addition, 12 samples were estimated

Summary of Experiments Measuring MeBr Emissions

>- Methyl bromide loss rates from 27 to 87% have been reported after application at 25 cm and covering the soil surface with high-density polyethylene (HDPE) plastic films.

>- In the Riverside vicinity, when methyl bromide is injected at approximately 25-30 cm and the soil covered with HDPE, the total loss rate for sandy loam soils (i.e., Greenfield and Arlington sandy loam) is consistently 60-65% of the total applied (Table I & Wang et al., 1997b).

>- Total volatilization after deep-soil injection has been shown to be smaller (Table I & Wang et al., 1997b), however, pest control may suffer.

>- Little information is available concerning methyl bromide volatilization when the soil is covered with virtually-impermeable plastic films.

>- No information exists on the total MeBr loss from partially-covered bedded soils.

Flux Meas

>- Flux measurements terminated at day 15 since MeBr volatilization was below detection.

>- For the I-EDPE-10 day plot, the 56.4% loss rate can be attributed to lower measured flux values during the first few hours after application.

>- This is the third experiment where ~60-65% total loss was observed for shallow-tarped application and provides evidence that this is "typical" for sandy loam soils near Riverside.

>- Total losses for the plots covered for 10 or 15 days with VIF were less than 3%. Covering the plots for only 5 days allowed 37% of the applied MeBr to escape (Table 2).

>- Total losses were not significantly different between the two application rates under Hytibar film. Emissions below 5% are likely for standard application rates.

Table 2. Total Emissions - 1996 Experiment (Wang et al., 1997a)

Plastic Material	Dosage [kg/ha]	Cover Time [d]	Volatilization Loss			
			At			
			5d	10d	15d	20d
<i>HDPE</i>	280	0-15	63.6	66.9	66.9	66.9
<i>HDPE</i>	280	0-10	49.3	54.8	56.4	56.4
<i>HDPE</i>	280	0-5	61.9	67.7	68.0	68.0
<i>Hytibar§</i>	210	0-15	1.5	1.8	1.9	3.2
<i>Hytibar</i>	210	0-10	1.0	1.4	1.8	1.8
<i>Hytibar</i>	210	0-5	1.9	33.9	36.2	36.2
<i>Hytibar</i>	140	0-15	0.9	1.0	1.1	1.1
<i>Hytibar</i>	140	0-10	2.6	2.9	29	2.9
<i>Hytibar</i>	140	0-5	10.4	38.5	38.8	38.8

Note: Numbers in bold indicate the field was not covered during the previous 5 day period.

Mass Balance

>- Br concentration in the soil was very high (50-130 mg g⁻¹) in the upper 1 cm and decreased rapidly to less than 5 (mg g⁻¹) in the subsurface soils (below 5 cm). Mass balances were 87 to 108% for the HDPE plots and 95 to 105% for the VIF plots.

Pest Control (Table 3)

>-Nutsedge seeds germinated prior to MeBr application, therefore, all cases had good control.

>-Good control was observed for standard methods and for VIF with a 210 kg/ha MeBr rate.

>-Reducing application rates to 140 kg/ha did not control fungi and may not control nutsedge.

Table 3. Pest Control - 1996 Experiment (Wang et al., 1997a)

Tarp	Dosage kg/ha	nematode	Pest Control	
			nutsedge§ %killed	fungus
HDPE	280	100	100	100
Hytibar	210	100	100	75
Hytibar	140	100	100	0

Conclusions

>- The reduced dosage alone lowers the emission rate by 25-50%.

>-Using both a virtually-impermeable film and a reduced application rate significantly lowers MeBr emission loss.

>- For the standard application methodology under the tested conditions, 190 kg/ha (i.e., 68% x 280 kg/ha of MeBr would enter the atmosphere.

>- Virtually-impermeable films offer the potential to reduce application rates below 280 kg/ha.

>- Using Hytibar film and a 25% reduction in the application rate, only 76 kg/ha (i.e., 36.2% x 210 kg/ha) would be lost, which is only 40% of standard methodology.

>- Increasing the cover period to 10 days reduces emission losses to 3.8 kg/ha (i.e., 1.8% x 210 kg/ha) which is 50 times less than standard methods. Clearly, significant emission reduction can be achieved.

!)!- Further testing of virtually-impermeable films is needed to determine fumigant loss for other environmental conditions and to ensure adequate pest control. This is an urgent need.

Will Using Virtually Impermeable Films Eliminate Methyl Bromide Emissions From PrePlant Fumigation?

>- If these results can be applied to all pre-plant soil fumigation, the global atmospheric MeBr burden from pre-plant fumigation will be reduced from 32 Gg y⁻¹ (Yvon-Lewis and Butler, 1997; 32 Gg y⁻¹ is about 25% of the total sources) to less than 1 Gg y⁻¹, which represents less than 0.5% of the total sources and less than 0.4% of the total sinks of atmospheric MeBr.

>- In the context of stratospheric ozone depletion from using methyl bromide for pre-plant soil fumigation, the uncertainty of all the global sources and sinks far exceed these small quantities.

>- Therefore, if these results extrapolate to all soils and conditions, the problem of stratospheric ozone depletion from soil pre-plant fumigation can be eliminated.

References

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